California LCFS fuel pathway modification: Used cooking oil to biodiesel in Taiwan with electricity and heating oil as sources for processing energy

GREET modeling technical support document

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I. Introduction (Public)

We are applying to add a new pathway to the California LCFS fuel carbon-intensity lookup table. This pathway is a modification to the published Midwest UCO pathway GREET model [1]. The pathway under consideration does not use "cooking" to refine the UCO.

Except for the points of deviation summarized below, our pathway is identical to the Midwest UCO pathway GREET model. The pathway differs only in the following:

1) The feedstock and fuel are both produced in Taiwan and the fuel is shipped to California via ocean tanker for distribution and consumption,
2) Electricity mix is specific to Taiwan, and
3) Values specific to the Taiwan facility, including the use of electricity and heating oil, are used in the calculation of fuel production energy use.

This application is for low-FFA or "yellow grease" UCO. Based on our modeling in CA-GREET, we find that the modified pathway has a carbon intensity of **25.62** $gCO_2e\ MJ^{-1}$.

II. Company Details (Below section is Public except the part highlighted and marked as confidential)

The Taiwan NJC Corporation biodiesel plant is a biodiesel production facility located at No. 45 Zhong-zheng Road, Min-xiong Industrial Park, Chiayi County 621, Taiwan. The facility began construction in 2005 and completed construction in 2006. It is owned by Taiwan NJC Corporation.

The Taiwan NJC Corporation biodiesel plant is capable of producing 6,604,300 gallons (25,000,000 liters) of biodiesel per year as documented by Taiwan Environmental Protection Administration Permit.

UCO is purchased from suppliers or collectors who collect oil from food production facilities and restaurants. The UCO is not sourced from any municipal waste facilities. The suppliers are required to certify by letter or within their supply contracts that they have collected the UCO only from food production sites and/or restaurants and that they took commercially reasonable efforts to keep the UCO separate from other waste materials and that it contains only incidental other components.

EcoEngineers conducted an on-site 3rd party engineering review of the Taiwan NJC Corporation biodiesel plant on May 30, 2012, as required under 40CFR Part 80, section 1450 to register under the EPA's Renewable Fuels Standard. EcoEngineers met with Allen Chang, Vice General Manager and Alan Wang, Marketing Executive of Taiwan NJC Corporation. The on-site review included a review of information provided by the

facility prior to the visit, a tour of the quality control laboratory and biodiesel plant, and the performance of a mass balance audit with review of additional information provided on UCO collection vendors, invoices, and permit information.

III. Table of changes to baseline CA-GREET model inputs for the Taiwan NJC pathway (Company specific information in below table is confidential business information)

The modified input values to CA-GREET spreadsheet is in Table 1. Results can be found in the "UCO Results" tab.

Table 1: Changes from CA_GREET spreadsheet for Midwest UCO biodiesel pathway to Taiwan NJC UCO biodiesel pathway (Private)

Parameter	Cell location	Midwest UCO value	Taiwan UCO value	Units	Explanation
Region for Analysis	Regional LT!C2	Midwest	Taiwan		
Region for Analysis	Regional LT!J6	Midwest	Taiwan		
Res. oil electric generation	Regional LT!J83	0.0%	[redacted]	%	[redacted]
Natural gas electric generation	Regional LT!J84	33.5%	[redacted]	%	[redacted]
Coal electric generation	Regional LT!J85	51.6%	[redacted]	%	[redacted]
Nuclear electric generation	Regional LT!J86	0.0%	[redacted]	%	[redacted]
Biomass electric generation	Regional LT!J87	5.8%	[redacted]	%	[redacted]
Other (renewables) electric generation	Regional LT!J88	9.1%	[redacted]	%	[redacted]
UCO processing energy (btu/lb. UCO)	UCO BD!B11	1073	[redacted]		[redacted]
Glycerine co-product yield	UCO BD!C41	0.105	[redacted]	lb/lb BD	[redacted]
UCO processing energy (% natural gas)	UCO BD!C174	89.8	[redacted]	%	[redacted]
UCO processing energy (% electricity)	UCO BD!C177	10.2	[redacted]	%	[redacted]
FFA transesterification NG use	UCO BD!E189	155	[redacted]	btu/lb BD	[redacted]
FFA transesterification residual oil use	UCO BD!E186	0	[redacted]	btu/lb BD	[redacted]
FFA	UCO BD!E192	16	[redacted]	btu/lb	[redacted]

transesterification electricity use				BD	
UCO transesterification NG use	UCO BD!F189	889	[redacted]	btu/lb BD	[redacted]
UCO transesterification residual oil use	UCO BD!F186	0	[redacted]	btu/lb BD	[redacted]
UCO transesterification electricity use	UCO BD!F192	47	[redacted]	btu/lb BD	[redacted]
UCO transesterification methanol use	UCO BD!F194	865	[redacted]	btu/lb BD	[redacted]
Biodiesel ocean tanker payload (tons)	T&D!V5	--	[redacted]	Tons	[redacted]
Biodiesel ocean tanker horsepower requirement	T&D!T12	--	[redacted]	hp	[redacted]
Ocean tanker transport distance	T&D!GB93	6594	[redacted]	miles	[redacted]
UCO transport distance	T&D!II93	50	[redacted]	miles	[redacted]
Biodiesel truck transport distance	T&D!GC93	50	[redacted]	miles	[redacted]
Column for biodiesel ocean tanker	T&D!GB90:132	Move right (insert new transport column)			
Title	T&D!GB91	--	Ocean Tanker		[redacted]
Ocean tanker fraction urban emissions	T&D!GB92	--	[redacted]	%	[redacted]
Ocean tanker transport distance	T&D!GB93	--	[redacted]	miles	[redacted]
Ocean tanker fraction diesel power	T&D!GB95	--	[redacted]	%	[redacted]
Ocean tanker fraction residual oil power	T&D!GB96	--	[redacted]	%	[redacted]
Ocean tanker outbound energy intensity	T&D!GB108	--	[redacted]	btu/ton-mile	[redacted]
Fraction of biodiesel transported by ocean tanker	T&D!CL138	0	[redacted]	%	[redacted]
Fraction of biodiesel transported by truck	T&D!CL142	80	[redacted]	%	[redacted]

IV. Basis for the Input Values (Below section is Public except the part highlighted and marked as confidential)

This pathway is similar to the published CA GREET model for UCO biodiesel from Midwest, with changes in the following areas as further detailed below:

1. electricity generation mix
2. fuel production energy use
3. transport modes and distances

The modified CA-GREET spreadsheet is included in the application package; results can be found in the "UCO Results" tabs.

The Taiwan NJC Corporation biodiesel uses electricity from the Taiwan grid and heating oil for its process energy requirements. Total electricity and heating oil consumption from January 2012 to September 2013 is provided in Section XII of this application. Taiwan's current electric generation mix is 53.9% coal, 19.3% natural gas, 18.1% nuclear, 3.8% residual oil, 1.5% biomass, and 3.4% others [2]. The produced biodiesel is transported using ocean tankers from Taiwan port to CA port, and then distributed using trucks.

Energy use values in the submitted pathway are based on facility data from January 2012 to September 2013 when low-FFA UCO feedstock was used. This application is only for a new pathway for a low-FFA yellow grease biodiesel at TNJC, which has a carbon intensity of **25.62 $gCO_2e\ MJ^{-1}$**.

V. CA-GREET Model Output

Table 2: Energy use and emissions from UCO biodiesel produced in the Midwestern U.S. and in Taiwan, separated by life cycle stage. Figures are rounded. (Private)

	UCOME Cooking Not Required, Fuel produced in the Midwest		**UCOME Cooking Not Required, Fuel produced in Taiwan**		**% difference**	
	Energy (BTU/MMBTU BD)	**Emissions (gCO2e/MJ)**	**Energy (BTU/MMBTU BD)**	**Emissions (gCO2e/MJ)**	**Energy (BTU/MMBTU BD)**	**Emissions (gCO2e/MJ)**
UCO Transport to Rendering Plant	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Rendering of UCO	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

UCO Transport (after rendering)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Biodiesel Production	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Biodiesel Transport	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total (Well To Tank)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total (Tank To Wheel)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total (Well To Wheel)	[redacted]	[redacted]	[redacted]	25.62	[redacted]	[redacted]

* NA indicate values that could not be found in references [1] or [4].

VI. Discussion of Results

Table 2 compares energy use and emissions from the proposed pathway to those from reference [1] for UCO biodiesel produced in the Midwestern U.S. without cooking. The UCO is rendered before being transported to the TNJC biodiesel plant; energy use data for rendering is not available from the plant. We assume the same energy consumption for this rendering in TNJC pathway as in the Midwest pathway. As a result, emissions from UCO rendering are similar for production in Taiwan compared to production in the Midwestern U.S. The majority of the emissions for both pathways come from the biodiesel production, in which production in Taiwan consumes more energy than production in the Midwestern U.S. Shipping the UCO from Taiwan by ocean tanker creates more emissions than shipping UCO from the Midwest by rail.

VII. Production Range of the Taiwan NJC Corporation Pathway (Public)

The new pathway should be applicable to the Taiwan NJC Corporation biodiesel plant for 100% (25,000,000 liters/year) of Permitted Capacity.

VIII. Sustainability of the Taiwan NJC Corporation Pathway (Public)

The Taiwan NJC Corporation biodiesel plant was designed and constructed using well-established modern designs and equipment and is managed by professional staff well-qualified to assure that over time the energy efficiency of and emissions from the facility do not deteriorate. Any deterioration would result in a less profitable business. Thus the sustainability of the plant is well aligned with the business objectives of the owners.

IX. Impact on Land Use (Public)

Since the raw material discussed is Used Cooking Oil, there is no land use impact.

X. Conclusion (Public)

Based on our modeling in CA-GREET and the available data, we find that biodiesel produced from low-FFA or "yellow grease" UCO at the Taiwan NJC Corporation biodiesel plant has a carbon intensity of 25.62 $gCO_2e\ MJ^{-1}$.

XI. References (Public)

1. *Detailed California-Modified GREET Pathway for Biodiesel Produced in the Midwest from Used Cooking Oil and Used in California*. Version 2.0. California Environmental Protection Agency Air Resources Board, 2011.

2. *Electricity/Heat in Chinese Taipei in 2009.* International Energy Agency. http://www.iea.org/stats/electricitydata.asp?COUNTRY_CODE=TW

3. *Farnel Capital Incorporated. Port to port distances, 2013. Available from: http://www.searates.com/reference/portdistance/ (Accessed December 2, 2013).*

4. *Detailed California-Modified GREET Pathway for Biodiesel Produced in California from Used Cooking Oil.* Version 2.0. California Environmental Protection Agency Air Resources Board, 2009.

XII. Documents supporting Annual Quantities of electricity and heating oil use and biodiesel production (Private)

The 2012 and 2013 monthly utility bills and heating oil purchase authenticating the amounts of electricity shown in the table above are on the following pages.